New Bi-HEMT Technology with Low On-Resistance pHEMT for LTE Application

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Abstract

Monolithic Integration of pHEMT and InGaP HBT Technology on 150-mm GaAs Wafers has been widely used in 3G and WiMax applications. BiHEMT technology (H2W is the code name at WIN) provides useful degrees of freedom for the design of power amplifiers. HBT is used for the power cell to provide sufficient power output and linearity where required. pHEMT is used for bias-circuits and power switching to achieve high efficiency at low power mode.

Presently WIN semiconductors offers two versions of H2W technologies with variation in HBT current gain to address customer requirements. The pHEMT device performance is targeted for bias circuit design. Next generation device architectures that will support integrated solutions adding 4G LTE to the MMMB module require a pHEMT with reduced on-resistance to enable the design of in-line power switched devices. In order to improve the on-resistance, WIN Semiconductors has developed a new H2W technology with a single gate recess process and optimized pHEMT epi-structure design to improve rf switch performance in the H2W process offering and bring it in line with best available for stand-alone pHEMT switch technologies (Fig. 1).

The threshold voltage (I_{ds}= 1mA/mm) and drain-to-source current density (I_{dss}) of the pHEMT are -1 V and 335 mA/mm, respectively (Fig.2a). The on-resistance of the pHEMT is 0.9 ohm.mm, achieving a 50% on-resistance reduction compared with previous H2W versions (Fig. 2b). Gate leakage current and breakdown voltage of the pHEMT are maintained at their previous low level for normal rf switch operation (Fig 3). We evaluated the rf switch performance by using a single gate 9x125-μm device with series topology. The insertion losses are 0.1 and 0.15 dB for the new and original H2W processes respectively. Regarding switch linearity, 80 dBc of second-harmonic power and third-harmonic power were obtained with the device biased at -3V.

For the HBT, the typical turn-on voltage of the is 1.26V. The base layer is designed with dc current gain of 125. BC and EC breakdown voltages are 28V and 17V, respectively.(Table 1)

In summary, WIN Semiconductor's new H2W technology provides world class pHEMT performance combined with rugged and proven HBT technology for the design of next generation power amplifiers for LTE high linearity application.

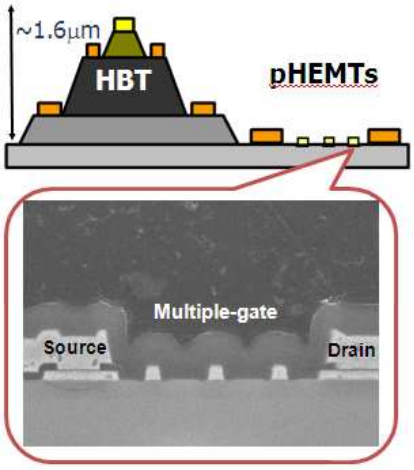

Fig1. SEM photograph of triple gate devices for rf-switch application

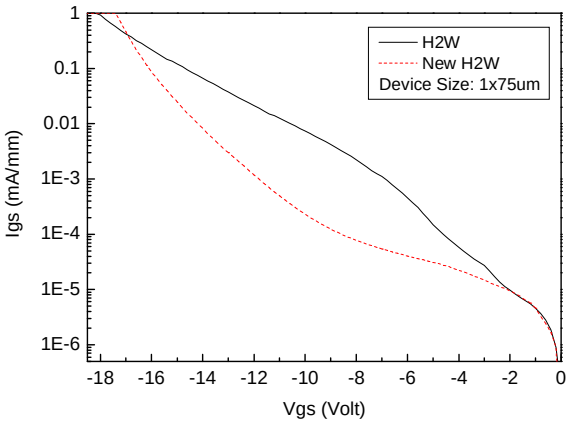

Fig3. Revised Schottky gate leakage characteristic of H2W.

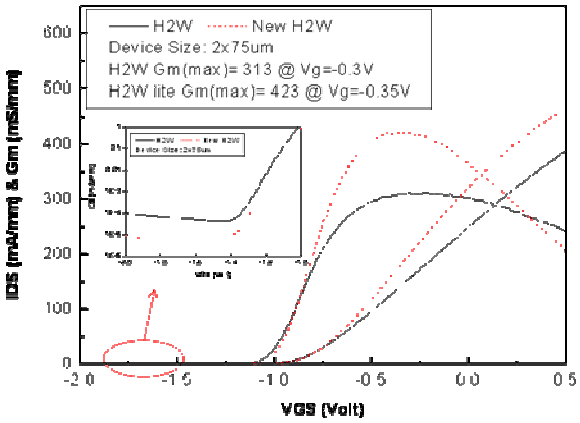

Fig2(a). The transfer curves of 0.5-μm pHEMTs of H2W

Table1. DC and RF performance summary of H2W

Device	Parameter	Description	Unit	High beta H2W	New H2W
HBT	BT_1m	Current gain @ ImA (2um X 20um X 2 HBT)	NA	125	125
	BK_CB	BC junction breakdown voltage	Volt	28	28
	ft	Current gain cut-off frequency of HBT	GHz	36.5	36.5
pHEMT	Gm_peak	Gm peak @ Vd=1.5V (D-mode)	mS/mm	340	450
	IDSS	Ids @ Vg=0V (D-mode)	mA/mm	265	335
	Ron	On resistance (D-mode)	Ohm-mm	1.7	0.9
	VDG	Breakdown voltage of Drain-Gate	Volt	20	16
	Vto	Threshold voltage @ Ids=1mA/mm	Volt	-1	-1
	ftD	pHEMT Current gain cut-off frequency	GHz	33	31
Capacitor	CP_M1_M2	MIM Capacitor	pF/mm²	600	570
	CP_CM_M2	Stack Capacitor	pF/mm²	900	870

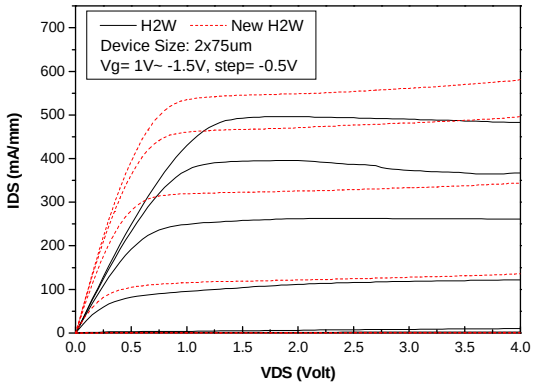

Fig2(b). The DC-IV characteristic comparison of H2W pHEMT devices